SLIP METER FOR DETERMINATION OF SURFACE SLIP RESISTANCE

[0001] The present invention relates to the measurement of slip resistance on surfaces at different installations including walking and vehicle travel roads, airfields, decks of naval ships, passageways, etc.

STATEMENT OF GOVERNMENT INTEREST

[0002] The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

[0003] The measurement of surface slip resistance is necessary to determine whether a surface is safe for walking of individuals or movement of equipment thereon, so as to prevent accidents for example. Slip meters for such purposes are generally known, such as the tribometer disclosed in U.S. Patent No. 5,259,236 to English. Such slip meter instruments are designed for manually controlled testing of smooth or textured surfaces, involving manual movement of a slip index gauge, pressure adjustment a hydraulic type of actuator and change of its air cylinder, as well as manual recording of slip index number. Furthermore, such prior art slip meters measure surface traction within a rather limited scale range, which often excludes some worn non-skid surfaces. It is therefore an important object of the present invention to provide a slip meter device that is portable and avoids the manual labor intensive tasks heretofore required for operation thereof, as well as to improve operational capability so as to enlarge coverage of surface traction area including worn non-skid surfaces and otherwise automate slip resistance measurement and make the slip meter device user friendly.

SUMMARY OF THE INVENTION

[0004] Pursuant to the present invention, a slip meter device is provided with a portable frame on which a magnetic type actuator is pivotally mounted for motorized displacement to a preselected angular position at an inclination angle to a test surface when the frame is positioned at the location to be tested. When so positioned, under a battery operated electrical energy source the magnetic actuator is energized to slidably displace a test specimen into contact with the test surface to apply a predetermined linear force to the test specimen through a strain gauge plate. Through one or more load cells mounted on the strain gauge plate under stress of the linear force being transmitted therethrough, strain measurement signals reflecting variations in slip resistance are fed to a computerizing circuit for direct automated output of slip resistance data.

BRIEF DESCRIPTION OF THE DRAWING

[0005] A more complete appreciation of the invention and many of its attendant advantages will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

[0006] FIG. 1 is a front elevation view of a slip resistance measuring device constructed in accordance with the present invention, positioned on a test surface;

[0007] FIG. 2 is a side elevation view of the slip resistance measuring device illustrated in FIG. 1;

[0008] FIG. 3 is a top section view taken substantially through a plane indicated by section line 3-3 in FIG. 2;

[0009] FIG. 4 is a partial side section view taken substantially through a plane indicated by section line 4-4 in FIG. 1;

[00010] FIG. 5 is a top partial view taken substantially through a plane indicated by section line 5-5 in FIG. 4;

[0011] FIG. 6 is a diagrammatic presentation of the device illustrated in FIGS. 1-5 and the circuitry associated therewith;

[0012] FIG. 7 is a top partial view corresponding to that of FIG. 5, illustrating another embodiment;

[0013] FIG. 8 is a simplified circuit diagram corresponding to the arrangement illustrated in FIG. 7; and

[0014] FIG. 9 is a graphical diagram operationally related to the arrangement illustrated in FIGS. 7 and 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] Referring now to the drawings in detail, FIGS. 1-3 illustrate a tribometer type of portable slip resistance measuring device 10 disposed on a surface 12 to be tested. The slip resistance measuring device 10 embodies a generally rectangular frame 14 through which various components of the device 10 are supported on the test surface 12, including an angularly positioned mast assembly 16 having a pair of mast arms 17 pivotally connected at their lower ends by hinges 19 to the frame 14, and a cross-beam 18 interconnecting the upper ends of the mast arms 17. An axially elongated magnetic actuator 20 is pivotally suspended by a hinge 22 at its upper end from the cross-beam 18 midway between the mast arms 17 as shown in FIG. 1. Projecting from the lower end of the magnetic actuator 20 is an actuator rod 24 connected through an attachment plate 26 to a strain gauge plate 28 having a test specimen 30 attached thereto adjacent its lower end as shown in FIGS. 1 and 4. The strain gauge plate 28 is angularly positioned at a predetermined inclination angle (32) to the test surface 12 as designated in FIGS. 2 and 4 by angular displacement of the mast arms 17 about the hinges 19 on the frame 14. Such angular positioning of the mast arms 17 and the magnetic actuator 20 with the strain gauge plate 28 is effected by means of an electric position adjustment motor 34 pivotally mounted on the frame 14 by a housing 36, as shown in FIGS. 1 and 2, enclosing control circuitry for pivotal displacement of the mast arms 17 through an actuator rod 38 extending from the motor 34 and pivotally connected to the mast arms 17 and to the magnetic actuator 20 by a hinge bracket 40.

[0016] The magnetic actuator 20 as shown in FIG. 1 includes a tubular housing 42 pivotally suspended from the mast cross-beam 18 by the hinge 22. The rod 24 extends from the housing 42 to the strain beam plate 28 for slidable displacement thereof. A magnetic coil 44 is enclosed within the housing 42 as shown in FIG. 4 for imparting a linear displacing force to the

rod 24 when the coil 44 is electrically energized. The magnetic actuator 20 thereby applies linear force through the rod 24 and the strain beam plate 28 to the test specimen 30 at the inclination angle 32 to the test surface 12. As a result of such magnetic action of the actuator 20, the test specimen 30 by engagement with the test surface 12 imposes a strain on the plate 28 sensed through a load cell 46 positioned thereon as diagrammed in FIG. 5 to provide electrical signal data on slip resistance.

[0017] FIG. 6 illustrates the operational relationship established in the slip resistance measuring device 10 as hereinbefore described. The electrical energy for effecting fully automatic operation of the device 10 is derived from a replaceable battery 48 connected through a start switch 50 to operational circuitry 52 connected to the magnetic coil 44 for energization thereof to operate the electromagnetic actuator 20 when the strain gauge plate 28 is positioned at the inclination angle 32 during slip resistance measurement, reflected by signals produced by the load cell 46, based on various known physical characteristics of the strain plate 28 and associated locational relationships, including strain (E) and distance (ℓ) between the load cell 46 on the strain plate 28 and the point from which force is applied through the test specimen 30 to the test surface 12 for strain measurement as shown in FIG. 6. Other characteristics and relationships involved include strain plate stress (σ), material modulus (E), applied moment (M), inertia (I), weight (W), thickness (h) and width (b). The signals so produced at the load cell 46 are fed to a computer circuit 53, diagrammed in FIG. 6, for direct and automated readout of slip resistance data.

[0018] According to another embodiment of the present invention as sown in FIG. 7, the strain plate 28 hereinbefore described is replaced by a strain plate 54, which is provided with two load cells 56a and 56b mounted thereon, spaced apart by a distance (ℓ) for measurement of strain

therebetween. The load cells 56a and 56b are connected to three terminals 58, 60 and 62 as shown in FIG. 7 and electrically diagrammed in FIG. 8. FIG. 9 graphically diagrams variations in slip resistance as a function of the changing strain (e) produced in the strain plate 54 and the spacings between the test specimen 30 and the load cells 56a and 56b connected through the signal terminals 58, 60 and 62 to the automated circuitry 52 as diagrammed in FIG. 6 through which measurement of the slip resistance of the surface 12 is effected.

[0019] As a result of the foregoing description of the portable slip resistance measuring device 10, the static and kinetic slip resisting friction of the surface 12, such as that of a non-skid deck, may be readily determined automatically by one person without manual data recordation.

[0020] Obviously, other modifications and variations of the present invention may be possible in light of the foregoing teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is: